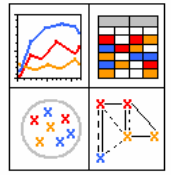
THERMAL MODELING SOLUTIONS



SUBMODEL NAME = HOKIES

	CALCULATED			ALLOWED	
MAX DIFF DELTA T PER ITER	DRLXCC(	0)= 1.00100	VS.	DRLXCA= 1.000000E-03	
MAX ARITH DELTA T PER ITER	ARLXCC(	0)= 1.00100	VS.	ARLXCA= 1.000000E-03	
MAX SYSTEM ENERGY BALANCE	EBALSC	= 1.000000E+30	VS.	EBALSA * ESUMIS	= 0.000000
				EBALSA= 1.000000E-03	
ENERGY INTO AND OUT OF SYS	ESUMIS	= 0.000000		ESUMOS= 0.000000	
MAX NODAL ENERGY BALANCE	EBALNC(	0)= 0.000000	VS.	EBALNA= 2.000000E-02	
NUMBER OF ITERATIONS	LOOPCT	= 0	VS.	NLOOPS= 5000	
PROBLEM TIME	TIMEN	= 0.000000	VS.	TIMEND= 0.000000	

DIFFUSION NODES IN INPUT NODE NUMBER ORDER

T 1=	5.0000	T 2=	5.0000	T 3=	5.0000	T 4=	5.0000	T 5=	5.0000	T 6=	5.0000
T 7=	5.0000	T 8=	5.0000	T 9=	5.0000	T 101=	5.0000	T 102=	5.0000	T 103=	5.0000
T 104=	5.0000	T 105=	5.0000	T 106=	5.0000	T 107=	5.0000	T 108=	5.0000	T 109=	5.0000
T 1001=	5.0000	T 1002=	5.0000	T 1003=	5.0000	T 1004=	5.0000	T 1005=	5.0000	T 1006=	5.0000
T 1007=	5.0000	T 1008=	5.0000	T 1009=	5.0000	T 1010=	5.0000	T 1011=	5.0000	T 1012=	5.0000
T 1013=	5.0000	T 1014=	5.0000	T 1015=	5.0000	T 1501=	5.0000	T 1502=	5.0000	T 1503=	5.0000
T 1504=	5.0000	T 1505=	5.0000	T 1506=	5.0000						

ARITHMETIC NODES IN INPUT NODE NUMBER ORDER

T 502=	5.0000	T 503=	5.0000	T 550=	5.0000	T 601=	5.0000	T 602=	5.0000	T 651=	5.0000
T 652=	5.0000	T 701=	5.0000	T 702=	5.0000	T 703=	5.0000	T 704=	5.0000	T 1302=	5.0000
T 1304=	5.0000	T 1402=	5.0000	T 1404=	5.0000						

HEATER NODES IN INPUT NODE NUMBER ORDER

++NONE++

BOUNDARY NODES IN INPUT NODE NUMBER ORDER

T 99999= 460.00

SYSTEMS IMPROVED NUMERICAL DIFFERENCING ANALYZER WITH FLUID INTEGRATOR PA 3

MODEL = SINDA85 HOKIESAT

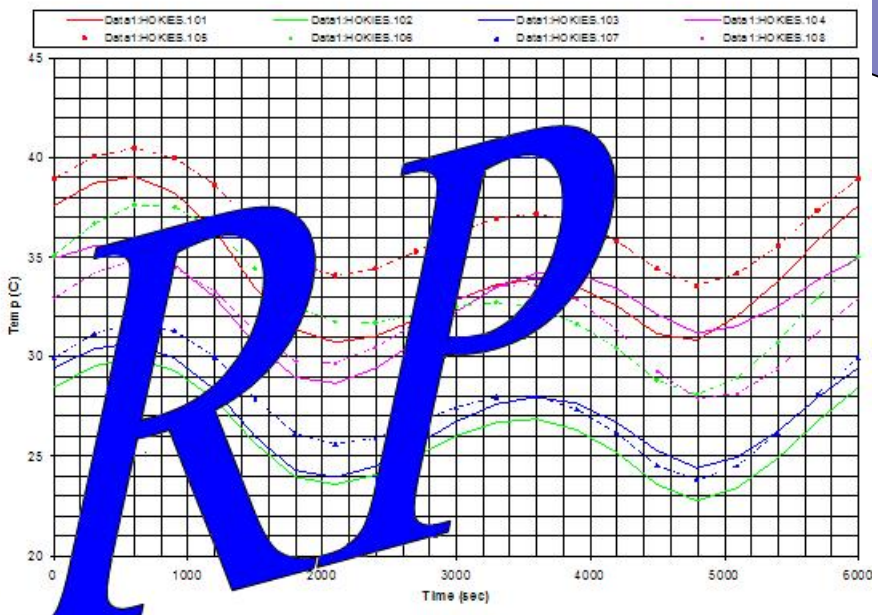
STDSTL

SUBMODEL NAME = HOKIES

	CALCULATED			ALLOWED	
MAX DIFF DELTA T PER ITER	DRLXCC(	0)= 1.001	VS.	DRLXCA= 1.000000E-03	
MAX ARITH DELTA T PER ITER	ARLXCC(	0)= 1.00	VS.	ARLXCA= 1.000000E-03	
MAX SYSTEM ENERGY BALANCE	EBALSC	= 1.000	VS.	EBALSA * ESUMIS	0.000000
				EBALSA= 1.000000E-03	
ENERGY INTO AND OUT OF SYS	ESUMIS	= 0.00		ESUMOS= 0.000000	
MAX NODAL ENERGY BALANCE	EBALNC(	0)= 0.00	VS.	EBALNA= 2.000000E-	
NUMBER OF ITERATIONS	LOOPCT	=	VS.	NLOOPS= 5000	
PROBLEM TIME	TIMEN	= 0.0	VS.	TIMEND= 0.000000	

DIFFUSION NODES IN INPUT NODE R ORDER

Q 1=	0.61328	Q 2=	9.9600	Q 3=	7.6449	Q 4=	4.0752	Q		Q	
Q 7=	8.2363	Q 8=	0.00000	Q 9=	8.1259	Q 1=	1.3668	Q 1	10.097	Q 1	
Q 104=	114.00	Q 105=	216.96	Q 106=	113.79	Q 107=	10.419	Q 1	0.00000	Q 1	
Q 1001=	0.44356	Q 1002=	0.44356	Q 1003=	0.44356	Q 1004=	0.44356	Q 1	0.44356	Q 1006	



Description		Node i	MID	Temp	
		Time	(6) SS	Format	
		Sigma	1.71E-09	Min Hea	
		Toffset	460	Heat to	

	In	Out
	23.01	7.33
ation	2.47	58.15
Source	20.11	-
Sum	65.58	65.47

Low (Out) to High (In):

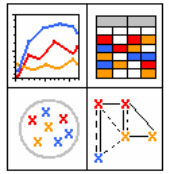
Description j	Node j	Type	Cond	Tem	Description j	Node j	Type	Cond	Temp j	Heat j
PPT-2 Fuel Bar	HOKIES.652	Lin	0.2079		Inner Panel Side	HOKIES.107	Lin	35.75	81.55	19.20
PPT-1 Fuel Bar	HOKIES.602	Lin	0.20	-3.59	Inner Panel Side	HOKIES.103	Lin	35.75	80.49	18.48
PPT-1 Capacitor	HOKIES.601	Lin	0.20	3.59	PPT-2 Capacitor	HOKIES.651	Lin	0.2079	80.02	3.74
PPT-2 Capacitor	HOKIES.651	Lin	0.2079	3.74	PPT-1 Capacitor	HOKIES.601	Lin	0.2079	81.02	3.59
Inner Panel Side	HOKIES.103	Lin								
Inner Panel Side	HOKIES.107	Lin								
SPACE	HOKIES.99999	Rad								
Inner Panel	HOKIES.109	Rad								
PPT-2 Fuel Bar	HOKIES.652	Rad								
PPT-1 Fuel Bar	HOKIES.602	Rad								
Outer Panel Bottom	HOKIES.8	Rad								
Battery Box External - Side	HOKIES.1504	Rad								
Battery Box External - Side	HOKIES.1502	Rad	0.001187	89.15	0.01	PPT-2 Capacitor	HOKIES.651	Rad	0.02082	80.02	0.17
Downlink	HOKIES.503	Rad	0.001492	89.02	0.02	Outer Panel Side	HOKIES.4	Rad	0.01023	90.45	0.17
Outer Panel Top	HOKIES.1	Rad	0.001528	93.07	0.03	SBand PMod	HOKIES.703	Rad	0.007188	95.49	0.16
GPS Mod	HOKIES.704	Rad	0.001902	93.13	0.04	PPU	HOKIES.701	Rad	0.008743	93.29	0.14
Outer Panel Side	HOKIES.7	Rad	0.012754	81.80	0.04	Outer Panel Side	HOKIES.3	Rad	0.013358	80.78	0.04
Outer Panel Side	HOKIES.3	Rad	0.013358	80.78	0.04	Outer Panel Side	HOKIES.7	Rad	0.012754	81.80	0.04
PPU	HOKIES.701	Rad	0.008743	93.29	0.14	GPS Mod	HOKIES.704	Rad	0.001902	93.13	0.04
SBand PMod	HOKIES.703	Rad	0.007188	95.49	0.16	Outer Panel Top	HOKIES.1	Rad	0.001528	93.07	0.03
Outer Panel Side	HOKIES.4	Rad	0.01023	90.45	0.17	Downlink	HOKIES.503	Rad	0.001492	89.02	0.02
PPT-2 Capacitor	HOKIES.651	Rad	0.02082	80.02	0.17	Battery Box External - Side	HOKIES.1502	Rad	0.001187	89.15	0.01
Crosslink	HOKIES.702	Rad	0.011388	92.98	0.20	Battery Box External - Side	HOKIES.1504	Rad	0.001002	89.11	0.01
PPT-1 Capacitor	HOKIES.601	Rad	0.02096	81.02	0.20	Outer Panel Bottom	HOKIES.8	Rad	0.000919	88.94	0.01
Outer Panel Side	HOKIES.6	Rad	0.01469	90.84	0.20	PPT-1 Fuel Bar	HOKIES.602	Rad	0.0149	63.75	-0.16
Outer Panel Side	HOKIES.5	Rad	0.0104	97.28	0.26	PPT-2 Fuel Bar	HOKIES.652	Rad	0.01582	62.04	-0.21
Battery Box External - Top	HOKIES.1501	Rad	0.03187	89.16	0.35	Inner Panel	HOKIES.109	Rad	0.03827	20.89	-1.87
CPU	HOKIES.502	Rad	0.02957	88.99	0.42	SPACE	HOKIES.99999	Rad	0.39274	-460.00	-55.91

Sheet:	NodeInfo		Data1	Data1	Data1
Parameter:	LowLimit	HighLimit	Min	Avg	Max
Description	Node/Group				
Outer Panel Top	HOKIES.1	15.0	35.0	30.7	34.3	39.1
Outer Panel Side	HOKIES.2	15.0	35.0	22.9	26.3	30.0
Outer Panel Side	HOKIES.3	15.0	35.0	24.1	27.3	30.9
				28.7	32.7	35.5
				33.3	36.5	40.2
				28.1	32.9	37.5
				23.9	27.9	31.8
				27.9	31.7	34.8
Inner Panel Top	HOKIES.101	15.0	35.0	30.7	34.3	39.1
Inner Panel Side	HOKIES.102	15.0	35.0	22.8	26.2	29.9
Inner Panel Side	HOKIES.103	15.0	35.0	23.9	27.2	30.7
Inner Panel Side	HOKIES.104	15.0	35.0	28.7	32.8	35.6
Inner Panel Side	HOKIES.105	15.0	35.0	33.6	36.8	40.5
Inner Panel Side	HOKIES.106	15.0	35.0	28.1	33.0	37.6
Inner Panel Side	HOKIES.107	15.0	35.0	23.8	27.7	31.7
Inner Panel Bottom	HOKIES.108	15.0	35.0	27.9	31.8	34.8

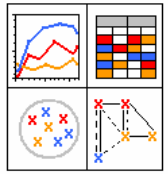
TARP

Thermal Analysis Results Processor

THERMAL MODELING SOLUTIONS



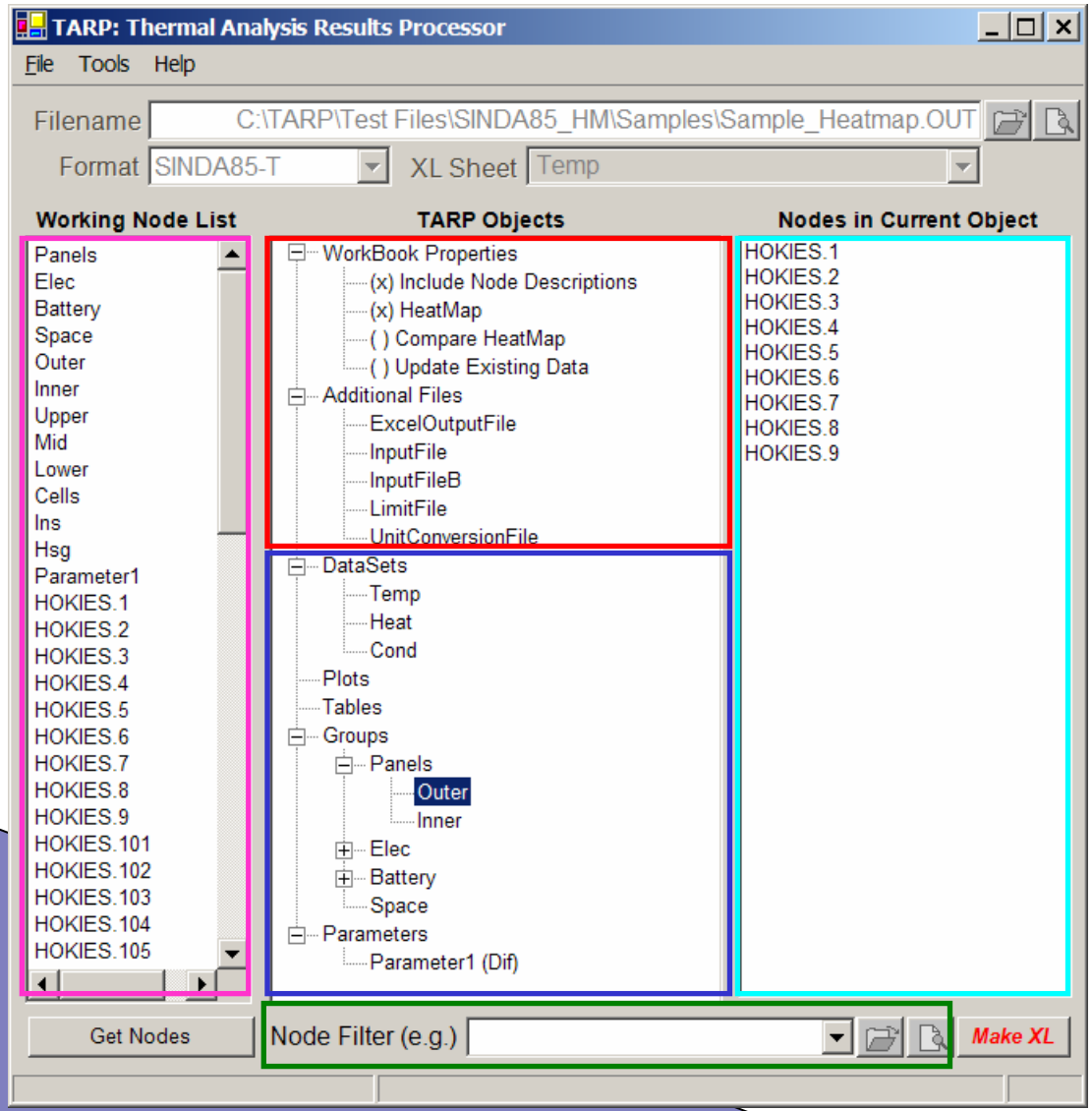
- **Commercial Thermal solvers provide temperature output for models based on heat and conductor inputs**
- **The post-processing of results is generally left to the user. However, common methods for displaying output results can be identified.**
- **TARP generates objects to display data in some of the more common ways, including: DataSets, Plots, Tables, Groups, Parameters, and HeatMaps within the Microsoft Excel® environment. All the requested data is then available in Excel® for further processing if needed.**



- **TARP takes an object-oriented approach to post-processing, allowing the user to create and define specified object types and Workbook properties within the TARP environment. These object types include:**
  - **DataSets: Sheets containing raw Data from output files**
  - **Plots: 2D representation of Data versus Time**
  - **Tables: 1D representation of Data at static points in Time**
  - **Groups: Additional data point(s) representing multiple raw data points**
  - **Parameters: Additional data point(s) representing a formula evaluation applied to multiple raw data points**
  - **HeatMaps: Specialized workbook to show heat flow between data points or Groups**
- **Once defined, an Excel® workbook is created containing the objects requested and defined by the user**

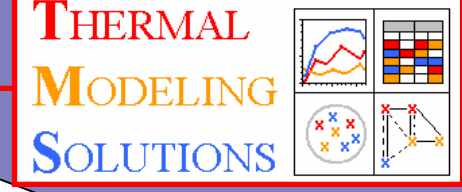
TARP – Main Interface

THERMAL MODELING SOLUTIONS



- **Options set by user to define additional file references and properties of the output workbook**
- **Objects created by user**
  - **DataSets**
  - **Plots**
  - **Tables**
  - **Groups**
  - **Parameters**
- **Node Filter accepts ranges (1-100) and/or individual nodes (SUB.1)**
- **Data added to Objects via the "Working Node List"**
- **Nodes displayed for current object**

TARP – Example 1, Simple Output

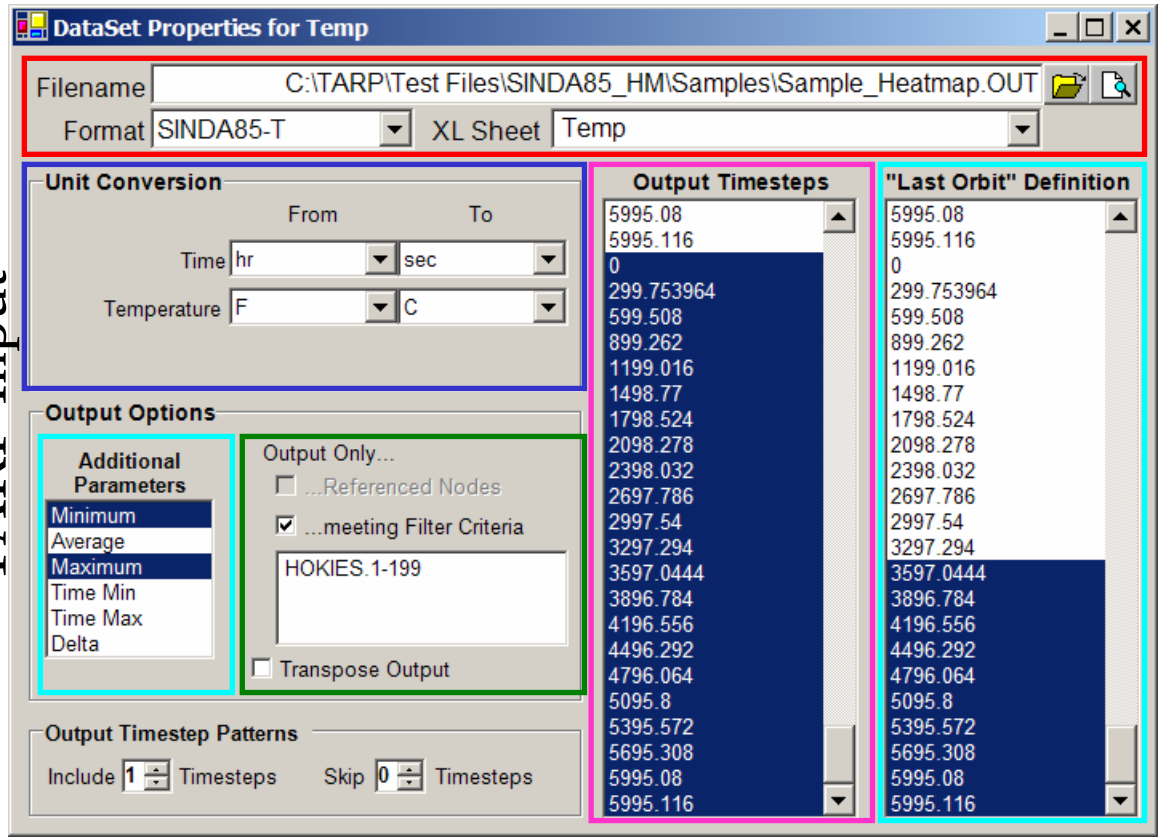


- At the Main Interface, expand the *DataSets* in *TARP Objects*
- Select *Data1*
- Click the Browse Button (Open Folder) to the right of the *Filename* textbox and select the Sample_Heatmap.out file in the Samples directory
- Notice that the nodes contained in the file have been loaded into the *Working Node List*. For this exercise, we will not be using the *Working Node List*, but this is where the nodes can be filtered to display only nodes of interest
- Right Click on *DataSets* and select *Add Object*. Alternatively, you could have right-clicked anywhere in the *TARP Objects* and selected *Add DataSet*
- Make sure *Data2* is selected in the *Object Tree* and again set the *Filename* to Sample_Heatmap.out, but this time change the *Format* to SINDA85-Q
- Select *Data1*, wait about 1 second, and click it again. It should now display a textbox with the name selected. Change the *Data1* name to *Temp*. This will now be the sheet name for DataSet 1.
- Select *Data2* and change the *XL Sheet* value to Heat. This is another way to change the sheet names.
- Now click *Make XL* to generate the output workbook
- Upon opening, take notice of the comment in Cell D1. This displays information on the file location, size, and data for traceability

TARP – DataSet Properties

THERMAL MODELING SOLUTIONS

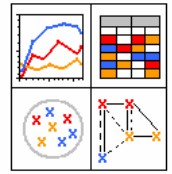
TARP Input



Output

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
2	MajorGrou	MinorGrou	SubGroup	Node#	0	299.754	599.508	899.262	1199.016	1498.77	1798.524	2098.278	2398.032	2697
3				HOKIES.1	37.6	38.71667	39.05556	38.23334	36.35334	33.46056	31.37722	30.72722	31.01556	31.8
4				HOKIES.2	28.59333	29.67056	30.03833	29.42667	27.97389	25.72889	24.06833	23.70778	24.18556	25.1
5				HOKIES.3	29.64056	30.605	30.85389	30.09389	28.49889	26.13222	24.44611	24.09167	24.65667	25.7
6				HOKIES.4	34.86722	35.51556	35.50889	34.63389	33.01389	30.67945	28.98333	28.65833	29.39445	30.7
7				HOKIES.5	38.66667	39.78334	40.21667	39.7	38.33889	36.18222	34.35	33.78945	34.12445	34.9
8				HOKIES.6	34.98556	36.585	37.48167	37.36834	36.265	34.25278	32.33	31.59389	31.57056	31.9
9				HOKIES.7	30.09222	31.30834	31.83667	31.42334	30.13611	28.01778	26.26778	25.76167	26.05056	26.8
10				HOKIES.8	32.92	34.20945	34.81889	34.475	33.25611	31.24778	29.78	29.67722	30.44667	31.6
11				HOKIES.9	-72.3006	-72.1178	-71.9595	-71.8556	-71.8183	-71.8645	-71.9528	-72.0411	-72.1295	-72.
12				HOKIES.101	37.59722	38.71667	39.05556	38.23334	36.35222	33.46111	31.37889	30.72945	31.01834	3
13				HOKIES.102	28.45556	29.535	29.90833	29.30667	27.865	25.63111	23.96222	23.59167	24.06	25.0
14				HOKIES.103	29.45333	30.41167	30.66111	29.91278	28.33556	25.99	24.30278	23.94445	24.50278	25.5
15				HOKIES.104	34.93945	35.555	35.52056	34.62389	32.995	30.65833	28.97111	28.65778	29.41278	30.7
16				HOKIES.105	38.93334	40.05	40.48334	39.97222	38.61667	36.46556	34.63445	34.07334	34.40778	35
17				HOKIES.106	35.05389	36.68056	37.60334	37.51111	36.42222	34.42167	32.49334	31.74556	31.70111	
18				HOKIES.107	29.93945	31.15667	31.68778	31.27889	29.99667	27.88556	26.13556	25.62722	25.91222	26.6
19				HOKIES.108	32.92611	34.215	34.82445	34.48	33.25945	31.25111	29.78389	29.68167	30.45222	31.6
20				HOKIES.109	-6.17611	-6.16056	-6.14445	-6.13056	-6.12222	-6.12333	-6.13167	-6.14167	-6.15111	-6.1
21														

- **Can select File, Format, and Data Sheet Name**
- **Convert Units**
  - **Time, Temperature, Heat, Area, Conductance, Capacitance**
- **Control Node Output**
  - **All Nodes, Range of Nodes, Referenced Nodes, Transpose**
- **Control Timestep Output**
- **Control Last Orbit Output**
  - **Min, Avg, Max, etc**
  - **Definition of Last Orbit**



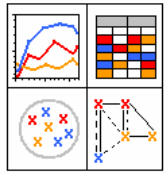
- **Many formats and parameters are supported in TARP including:**

Format	*Parameters*
SINDA85 & SINDA/FLUINT	T, Q, G, C*
SINDA/G	T, Q, G, C*, F*
ESATAN (PRNDBL)	T, Q, QS, QA, QE, QI, QR, G*, GL*, GR*, C*
ESATAN (PRNDTB)	T, Q, QS, QA, QE, QI, QR
TMG	T, Q (QNODEF), Q (REPF), G
TAK2000	T, Q, G, C*
TSS	Q, G*
ThermalDesktop	Q*, G*
Comma Separated Value	N/A
Space Delimited	N/A

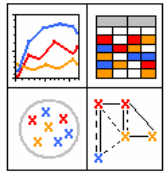
** Planned*

TARP – Example 2, DataSets

THERMAL MODELING SOLUTIONS



- **Create the *Temp* DataSet as in Example 1**
- **Double-click the *Temp* dataset in the *Object Tree* to bring up the properties form for the selected DataSet.**
- **Under the *Unit Conversion* section, set the *Time From* to "hr" and the *Time To* to "sec". Notice that the timesteps are now displayed in the updated units.**
- **Similarly, change the *Temperature From* to "°F" and the *Temperature To* to "°C". Notice that only units for a particular parameters are available (i.e. you cannot change heat units for a temperature DataSet)**
- **Currently, all of the timesteps should be selected. This data includes two SS outputs and 10 transient orbits (t=0 to 5995 x10). Typically, only the last orbits worth of data is of interest. Notice, that the *Last Orbit Definition* has selected only the last orbit range. For this example, we will only output the last orbit as well. Select the last group of timesteps starting with 0 and ending with 5995.**
- **The user may also define what is to be considered the "Last Orbit". Timesteps selected for the last orbit define the range of data for plots and the range of data for calculation of the orbit Minimum, Maximum, etc. Select the timesteps starting with 3597 and ending with 5995.**
- **Additional parameters may be output at the end of the data including: Minimum, Average, Maximum, Time Min, Time Min, and Delta (i.e. Maximum – Minimum). All of these values are calculated over the range of data specified by the user as the "Last Orbit"**

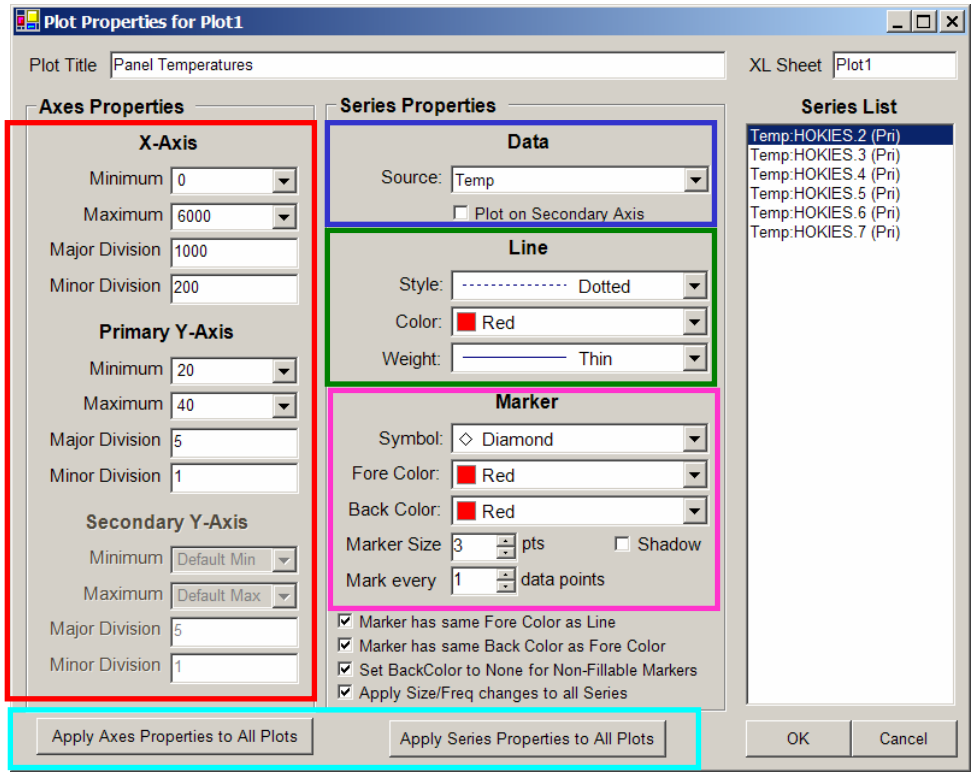


- **Subsets of nodes may also be output. Two methods exist for filtering the nodes: *Filter Criteria* and *Referenced Nodes Only*. Only one of these methods may be applied at a time.**
  - **Referenced nodes will output include any nodes included in a Table, Plot, Group, or Parameter. In addition, if a user has selected any nodes in the *Working Node List*, these nodes would also be included.**
  - **Filter Criteria will output any nodes meeting the user specified filter criteria. This criteria may include single nodes or ranges of nodes.**
- **Lastly, a user may transpose the output. By default, each row represents a node/ group and each column represents a timestep. Generally, models have significantly more nodes than timesteps. However, in some cases this may not be true.**
  - **Excel® has a limit of 256 columns total. Four columns are reserved for the Group definitions and node listing. Furthermore, if the user outputs Additional Parameters (e.g. minimum, maximum), up to six more columns may be used for these definitions.**
  - **Any remaining columns may be used for output timesteps. Transposing the data allows the user to output far more timesteps, but at the cost of a limited number of nodes (<256).**
- **Create the workbook by closing the properties form and clicking *Make XL* at the main interface.**

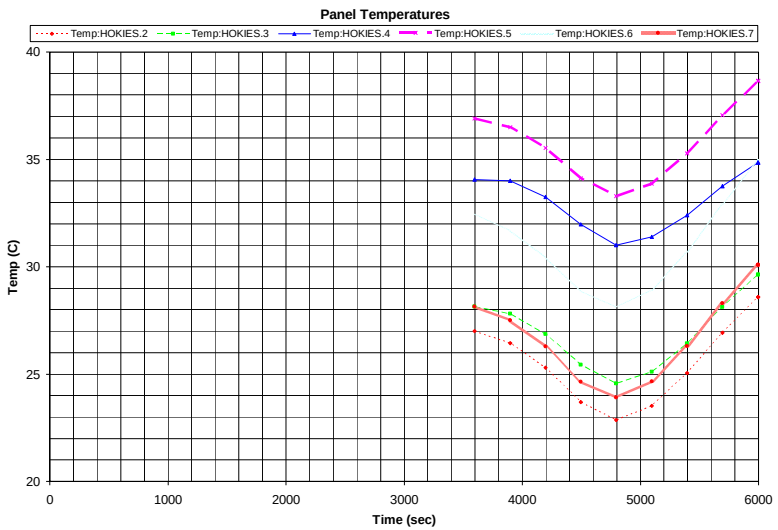
TARP – Plot Properties

THERMAL MODELING SOLUTIONS

TARP Input



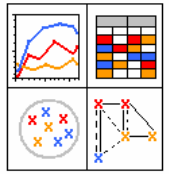
Output



- **Control X-Axis, Y-Axis, and Secondary Y-Axis properties**
  - **Minimum, Maximum, Major and Minor Division**
- **Control Source Data**
- **Control Line Properties**
  - **LineType, Color, Weight**
- **Control Marker Properties**
  - **ForeColor, BackColor, MarkerType, Size, Shadow, Frequency**
- **Apply formats to all Plots**

TARP – Example 3, Plotting

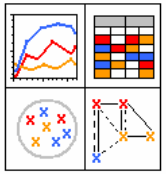
THERMAL MODELING SOLUTIONS



- **Create the Temp DataSet as defined in Example 2.**
- **In the *Node Filter* field at the main interface, type "503, 550, 601, 602" and press return. This will repopulate the *Working Node List* with only nodes meeting this criteria. A user may also enter ranges (e.g. 503-602) to reduce the working list to a subset of nodes of interest.**
- **Right click on the *Object Tree* and select *Add Plot***
- **Select the four nodes listed above on the *Working Node List* and right click to bring up a popup menu. Select *Plot1* under the *Add to Plot* submenu. These nodes now appear in the *Nodes in Current Object* listbox. Alternatively, the nodes could have been dragged from the *Working Node List* and dropped onto *Plot1* in the *TARP Objects* or the *Nodes In Current Object.* Note that as you drag over objects in *TARP Objects*, the current object and *Nodes In Current Object* changes**
- **For plots, additional information is also provided in the *Nodes in Current Object* listbox. This includes the source DataSet for the series and the plot axis. To change the source DataSet or axis, select the series, right click to access the popup menu, and select the correct source DataSet or axis.**
- **Plotting data on the secondary axis would be most likely used to plot the response of a sensing point to a heater cycle. In such a case, the Temperature and Heat would come from different source DataSets and be plotted on different axes.**
- **Nodes may be removed from a plot through the popup menu as well. A single node, a group of selected nodes, or a group of unselected nodes may be removed. They may also be removed by pressing the *Delete* key**
- **Double-click *Plot1* in *TARP Objects* to bring up the Properties form**

TARP – Example 3, Plotting (cont'd)

THERMAL MODELING SOLUTIONS



- **Change the axis properties to the values in the table below:**

Axis	Min	Max	Major Div	Minor Div
X	Default	Default	2000	500
Y	Default	Default	5	1

- **Selecting a series in the *Series List* allows the user to make changes to series properties (e.g. line style, marker type). Selecting multiple series will apply changes to all selected series**
- **Define the line and marker characteristics for each series as shown below:**

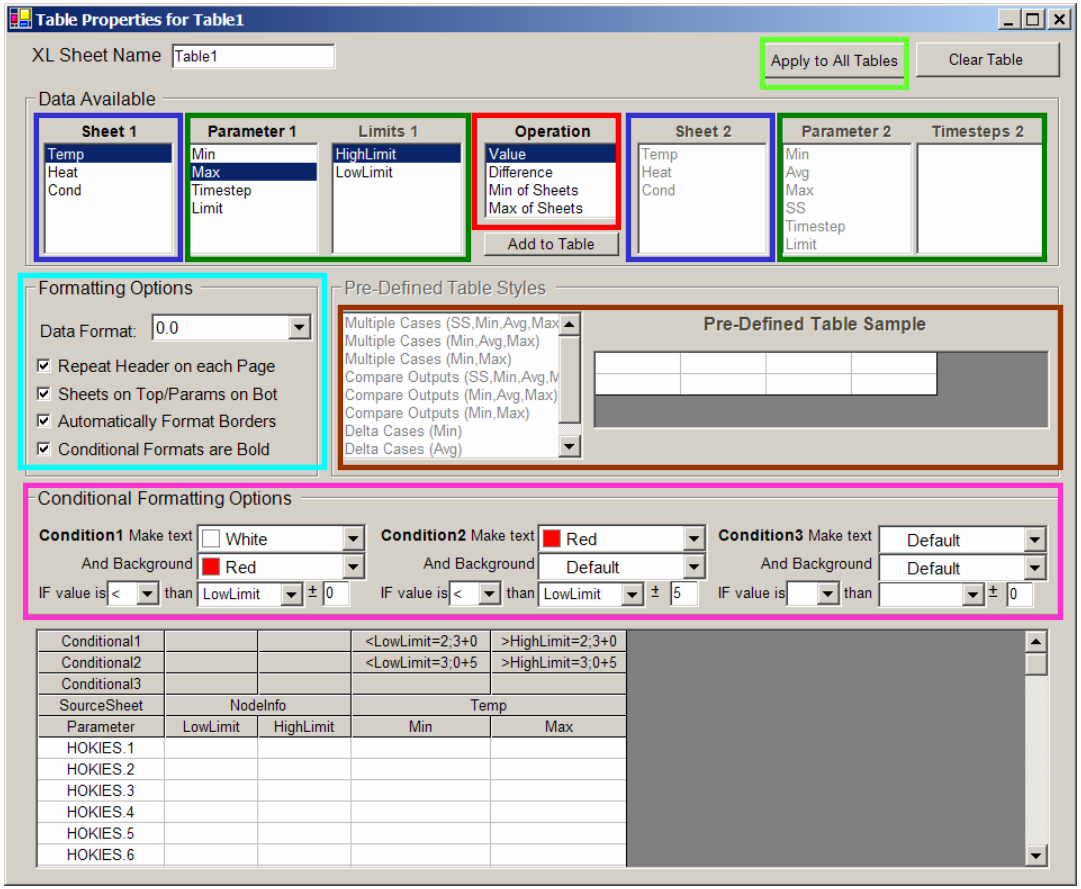
Node	Color	LineType	Marker Type	Filled?
HOKIES.503	Red	Solid	None	N/A
HOKIES.550	Blue	Dashed	Square	Yes
HOKIES.601	Pink	Dash-Dot	Triangle	No
HOKIES.602	Green	Solid	X	N/A

- **HINT: You may need to uncheck some of the marker options at the bottom.**
- **Axes and/or Series properties may be applied to all defined plots. However, if the current plot contains 3 series and another plot contains 8 series, then changes will only apply to the first 3 series on the 8 series plot.**
- **The *Apply Marker Freq/Size to all Series* can be used to make changes to all series on the current plot with respect to Marker Frequency and Marker Size.**
- **Close the properties form and create the workbook at the main interface.**

TARP – Table Properties

THERMAL MODELING SOLUTIONS

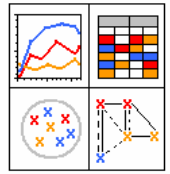
TARP Input



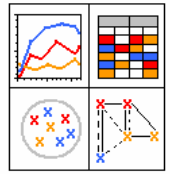
Output

	A	B	C	D	E	F
1		*Sheet:*	NodeInfo		Temp	
2		*Parameter:*	LowLimit	HighLimit	Min	Max
3	Description	Node/Group				
4	Outer Panel Side	HOKIES.2	15.0	35.0	22.9	28.6
5	Outer Panel Side	HOKIES.3	15.0	35.0	24.6	29.6
6	Outer Panel Side	HOKIES.4	15.0	35.0	31.0	34.9
7	Outer Panel Side	HOKIES.5	15.0	35.0	33.3	38.7
8	Outer Panel Side	HOKIES.6	15.0	35.0	28.1	35.0
9	Outer Panel Side	HOKIES.7	15.0	35.0	23.9	30.1
10						

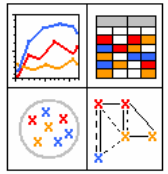
- **Select Tabular Type**
  - **Simple value, Difference, Max/Min of Sheets**
- **Select Source Sheet(s)**
- **Select Tabular Data**
  - **Minimum, Maximum, Average, Steady-State, Timestep, Limit**
- **Conditional Formatting to Highlight Out-of-Limit Conditions**
- **Formatting options for Table display**
- **Predefined tables for quick creation**
- **Apply formats to all Tables**



- Create the Temp and Heat DataSets from Example 1
- At the main form, create a table by right clicking on the *TARP Objects* and selecting *Add Table*
- Add nodes HOKIES.500-699 to *Table1*. Then double-click to bring up the properties
- Each column of data in a table has defining characteristics.
  - First, the Operation may be a simple value, a difference between two values, or a minimum or maximum over a collection of sheets
  - Next, the source sheet for the data should be defined, followed by the parameter to be output. Parameters include Minimum, Average, Maximum, Steady-State, any specified timestep, or a user defined limit. If a Timestep or Limit is specified, the user must then select the particular entry from the list.
  - Once all these values have been defined, the user may add this to the table by either double clicking the Parameter or clicking the *Add to Table* button. The column is then shown in the Table Preview pane.
  - For the Difference operation, these parameters must be selected for both entries
  - For the Min/Max of Sheets, more than one source sheet may be selected
- To change the order of columns, drag the existing column into the new position using the right mouse button
- Columns may be deleted by selecting the column to delete and pressing the Delete key

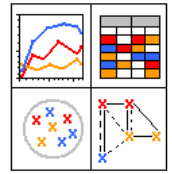


- **The user may define the number of decimal places to show for all values by selecting the pattern in the *Data Format* field.**
- **Columns with the same header can be grouped together. This header may be either the source DataSet or a parameter type. If a user wishes to group results from the same DataSet together (e.g. Data1), then the *Sheets on Top/Params on Bot* option should be checked. Conversely, if a user is grouping the same parameter type together (e.g. Min), then *Sheets on Top/Params on Bot* option should be unchecked.**
- **Additional formatting options are available to: make Conditional Formats bold, to Repeat Headers on subsequent page for printouts, and to automatically format the borders for the table.**
- **Conditional formatting allows a user to highlight data that exceeds user-defined limits. These limits are defined in an external, comma-separated ASCII file. The first line of this file should contain the "Node" label, followed by the limit names as defined by the user (e.g. Node, LowLimit, HighLimit). Once any limit is added to a table, the conditional formatting options will be enabled.**
- **Up to three conditions may be applied to any column. Each of these follows a simple pattern: If VALUE is [>,>=,<,<=] LIMITNAME +/- MARGIN Then set TEXTCOLOR, BACKGROUNDCOLOR accordingly. If Condition 1 or 2 is satisfied then the remaining conditions are ignored. The condition(s) applied to each column are shown at the top in the Table Preview. For example, to apply the condition: *If value is > HighLimit, THEN Set TEXT Red and BACKGROUND Default*, the pattern would look like "*>HighLimit+0=3,0*".**



- **The margin should generally be applied as a second or third condition, so that any limit violations would be identified first. In general, Conditional1 should be for a Red Limit, Conditional2 for a Yellow Limit, and Conditional3 to identify any values within X of the Yellow Limit.**
- **Some pre-defined table style are also available for the quick generation of tables. Select the Multiple Cases (Min, Avg, Max) predefined style and double click it. This will now generate columns of Min, Avg, and Max for each DataSet defined with source sheets on top (i.e. grouped together) and parameters on bottom.**
- **Notice that no Limits are available under the Parameters list. Close the properties form and select *Limit File* under the *Additional Files* grouping. Using the browse button, open the Sample.lim file. Now, bring up the properties again for *Table1*.**
- **Limits are now available. Add both the LowLimit and HighLimit to the table. Using the right mouse button, drag them such that the LowLimit and HighLimit columns are to the left of the Temp-Min column.**
- **Add conditional formatting to the Min/Max columns such that Conditional1 sets the background to red and the text to default if the high/low limit is violated. Make Conditional2 set the text to red and the background to default if the value is within 5 of the high/low limit. The resulting table should look as below. Create the workbook at the main interface as before.**

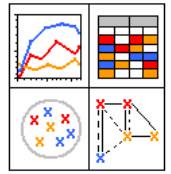
Conditional 1			< LowLimit+0=0,3		> HighLimit+0=0,3			
Conditional 2			< LowLimit+5=3,0		> HighLimit+5=3,0			
Conditional 3								
	NodeInfo		Temp			Heat		
Node	LowLimit	HighLimit	Min	Avg	Max	Min	Avg	Max



- **Groups create additional data points that may be plotted or tabulated**
- **Groups represent the average temperature or total heat load for a subset of nodes**
- **A node may only be defined in a single group. However, groups may be nested as subgroups to other groups, allowing a node to appear in up to three distinct groups.**
- **For the group hierarchies Inst:Scanner:Reflector, Inst2:Motor:Shaft, and Space, the table to the right shows how nodes may be defined in varying groups**

Node	*Defined In*	*Major*	*Minor*	*Sub*
1	Reflector	Inst	Scanner	Reflector
2	Scanner	Inst	Scanner	Scanner
3	Inst	Inst	Inst	Inst
4	Motor	Inst2	Motor	Motor
5	Motor	Inst2	Motor	Motor
6	Shaft	Inst2	Motor	Shaft
7	Space	Space	Space	Space

TARP – Example 5, Groups



- Create the DataSets defined in Example 1
- Select the *Groups* entity in the *Object Tree*. Right click and select *Add Group*
- Select Group1, pause for a second and select it again. The text should now be selected and modifiable. Change the name of *Group1* to *Panels*
- Panels is defined as a Major Group. For an full spacecraft model, these are intended for grouping together nodes at an instrument level.
- With *Panels* selected, right click again and select *Add Group. Group2* has now been added, but one difference is that *Group2* is a child-group of *Panels*. Up to three levels of groups may be defined (Major, Minor, Sub).
- Any nodes included in a minor group are also included in the parent major group. Similarly, any node defined in a major group is also propagated to exist at the minor and sub group levels (with the same group name as the major group).
- For HeatMaps, a fourth level of grouping is also available
  - Dynamic groups allow the user to change the group definitions within Excel®
  - By collapsing or expanding groups, the group containing nodes may be altered
  - For example, a spacecraft model with 5 instrument major groups may have one group expanded to its sub group level, while the other 4 major groups can be collapsed to their major group level
- Deleting a group can either promote its child groups or delete them. This option can be set under *Preferences*.

TARP – Example 5, Groups

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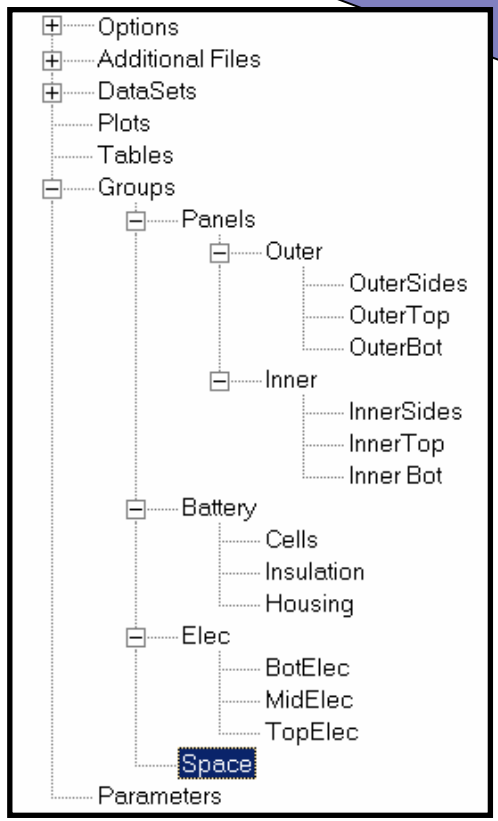
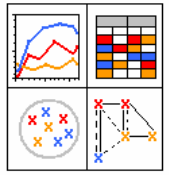
- **Create the DataSets defined in Example 2 and then create the groups as defined in the table below. The resulting Object Tree should look like the one to the right.**

Major Group Name	Minor Group Name	Sub Group Name	Nodes
Panels[1]	Outer[1]	OuterTop[2]	HOKIES.1
Panels[1]	Outer[1]	OuterSides[2]	HOKIES.2-7
Panels[1]	Outer[1]	OuterBot[2]	HOKIES.8
Panels[1]	Inner[1]	InnerTop[2]	HOKIES.101
Panels[1]	Inner[1]	InnerSides[2]	HOKIES.102-107
Panels[1]	Inner[1]	InnerBot[2]	HOKIES.108
Battery[1]	Cells[2]	Cells[3]	HOKIES.1001-1015
Battery[1]	Housing[2]	Housing[3]	HOKIES.1501-1506
Battery[1]	Insulation[2]	Insulation[3]	HOKIES.1301-1499
Elec[1]	BotElec[2]	BotElec[3]	HOKIES.502, 503, 550
Elec[1]	MidElec[2]	MidElec[3]	HOKIES.601, 602, 651, 652
Elec[1]	TopElec[2]	TopElec[3]	HOKIES.701, 702, 703, 704
Space[2]	Space[3]	Space[3]	HOKIES.99999



1. **These groups contain only child groups and no nodes. Nodes will be included by putting them into the child groups**
2. **These groups are where nodes should be explicitly added**
3. **These groups do not need to be explicitly created. They are created by default to preserve the groupings at lower group levels**



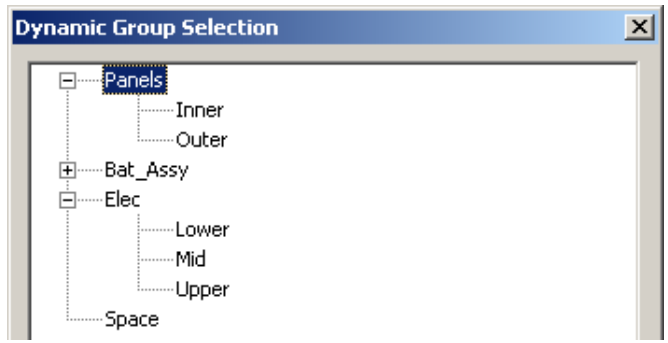
- **Parameters, like groups, create additional data points that may be plotted or tabulated**
- **5 types of Parameters may be defined: Difference between two nodes, Max/Min of nodes, and Max/Min of a Group**
- **Session files allow a user to save all definitions of all TARP objects and Workbook properties to an ASCII text file for later retrieval and modification**
- **The Session File follows a simple to understand format:**

  <Object>

  … Properties…

  End <Object>

- **HeatMaps are by far the most powerful feature of TARP, allowing a user to investigate heat flows between nodes and/or Groups.**
- **The user must output all Temperature, Conductor, and Heat data to use the HeatMap options. This data (along with the node pairings for a conductor) are read into a specialized workbook containing macros to calculate the heatflow for a given timestep. Heatflows may be shown between nodes, groups, or between nodes and groups.**
- **The user has the three basic levels of grouping available (Major, Minor, and Sub) as well as an additional Dynamic Groups option. This allows the user to expand or collapse any of the Groups to the detail desired.**



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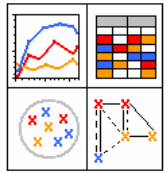


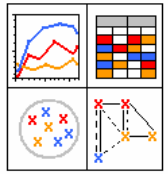
- The user must specify the Stefan-Boltzman constant, the offset to absolute temperature, and the time step of interest. At this point, the heat flow through all conductors is calculated and stored internally
- Once a node or Group is specified, all connected nodes/ groups are output to the Map1 worksheet. The "Min Heat" may be specified to only output relevant heat flows.
- A summary of the node/group is also provided showing the amount of heat transferred by mode and applied.
- The format may be changed to display more digits

Output

	A	B	C	D	E	F	G	H	I	J	K	L
1		Description	INNER PANEL TOP						SUMMARY:		In	Out
2		Node i	HOKIES.101		Temp	93.08			Conduction		67.17	67.37
3		Time	(6) SS		Format	0.00			Radiation		0.00	1.12
4		Sigma	1.71E-09		Min Heat	0.0			Source		1.37	-
5		Toffset	460		Heat to	Node			Sum		68.54	68.50
6												
7		*Low (Out) to High (In):*					*High (In) to Low (Out):*					
9		Description j	Node j	Type	Cond	Temp j	Heat j	Description j	Node j	Type	Cond	Temp j	Heat j
10		INNER PANEL SIDE	HOKIES.102	Lin	1.4989	78.80	-21.40	SBAND PMOD	HOKIES.703	Lin	20.076	95.49	48.52
11		INNER PANEL SIDE	HOKIES.103	Lin	1.4989	80.49	-18.87	INNER PANEL SIDE	HOKIES.105	Lin	1.4989	97.79	7.06
12		INNER PANEL SIDE	HOKIES.107	Lin	1.4989	81.55	-17.27	PPU	HOKIES.701	Lin	29.215	93.29	6.22
13		INNER PANEL SIDE	HOKIES.104	Lin	1.4989	90.58	-3.73	GPS MOD	HOKIES.704	Lin	97.496	93.13	5.36
14		INNER PANEL SIDE	HOKIES.106	Lin	1.4989	90.97	-3.16	OUTER PANEL TOP	HOKIES.1	Lin	100	93.07	-0.10
15		CROSSLINK	HOKIES.702	Lin	29.257	92.98	-2.84	CROSSLINK	HOKIES.702	Lin	29.257	92.98	-2.84
16		OUTER PANEL TOP	HOKIES.1	Lin	100	93.07	-0.10	INNER PANEL SIDE	HOKIES.106	Lin	1.4989	90.97	-3.16
17		GPS MOD	HOKIES.704	Lin	97.496	93.13	5.36	INNER PANEL SIDE	HOKIES.104	Lin	1.4989	90.58	-3.73
18		PPU	HOKIES.701	Lin	29.215	93.29	6.22	INNER PANEL SIDE	HOKIES.107	Lin	1.4989	81.55	-17.27
19		INNER PANEL SIDE	HOKIES.105	Lin	1.4989	97.79	7.06	INNER PANEL SIDE	HOKIES.103	Lin	1.4989	80.49	-18.87
20		SBAND PMOD	HOKIES.703	Lin	20.076	95.49	48.52	INNER PANEL SIDE	HOKIES.102	Lin	1.4989	78.80	-21.40
21		SPACE	HOKIES.99999	Rad	0.00632	-460.00	-1.01	SBAND PMOD	HOKIES.703	Rad	9.73E-06	95.49	0.00
22		INNER PANEL	HOKIES.109	Rad	0.00162	20.89	-0.11	OUTER PANEL SIDE	HOKIES.5	Rad	3.87E-06	97.28	0.00

- **Expand the *Options* grouping on the *Object Tree***
- **Select *HeatMap.* Notice that it is now indicated with an (x) to show that the HeatMap option is selected. This tells TARP to use a specialized workbook containing the macros needed to compute heatflow. HeatMaps also expect particular output which must include Temperatures, Heat Loads, and Conductors for each output interval. It *does not* need a QMAP or QDUMP output.**
- **Notice that three DataSets (*Temp, Heat, Cond*) have automatically been created. Select the Sample_Heatmap.out file for the *Temp* DataSet. When HeatMaps are enabled, the same file is used for all three DataSets.**
- **TARP also requires further information for SINDA and TAK output. The SINDA/TAK input file is needed to establish the node pairs connected by a conductor. Under *Additional Files* select *Input File* and load Sample_Heatmap.inp as the *Input File*.**
- **Next, define the groups as in Example 5**
- **Then create the output workbook. Upon opening, make sure to enable macros. The worksheet should look as below:**

	A	B	C	D	E	F	G	H	I	J	K	L
1		Description							SUMMARY:		In	Out
2		Node i			Temp				Conduction			
3		Time			Format	0.00			Radiation			
4		Sigma	5.67E-08		Min Heat	0.0			Source			-
5		Toffset	273.15		Heat to	Node			Sum		0.0	0.0
6												
7	*Low (Out) to High (In):*						*High (In) to Low (Out):*					
9	Description j	Node j	Type	Cond	Temp j	Heat j	Description j	Node j	Type	Cond	Temp j	Heat j



- **Enter 1.71e-9 for *Sigma* and 460 for *Toffset***
- **Select cell C3 and click the down arrow to the right. This will provide a list of valid timesteps from which to choose. Once the *Time*, *Sigma*, and *Toffset* are specified, the heat flow through all conductors is calculated. During this process, the heat flows are also assigned to the proper internal Node-to-Group and Group-to-Group heat flow arrays. Select entry *(6) SS* from the list**
- **Now, enter *HOKIES.101* into cell C2 and hit return. The workbook will now determine all nodes connected to HOKIES.101 and output them to the worksheet. The left hand side shows all heat flows sorted from largest heat out (<0) to largest heat in (>0), keeping linear and radiative heatflows grouped together. The right side shows the opposite order. The temperature and description of the specified node is also output.**
- **The top right area of the output gives an indication of how balanced the heatflow is for the node/group specified, listing the heat flow applied and in/out by mode.**

	Description	INNER PANEL TOP				SUMMARY:	In	Out
	Node i	HOKIES.101	Temp	93.08		Conduction	67.17	67.37
	Time	(6) SS	Format	0.00		Radiation	0.00	1.12
	Sigma	1.71E-09	Min Heat	0.0		Source	1.37	-
	Toffset	460	Heat to	Node		Sum	68.54	68.50

Low (Out) to High (In):						*High (In) to Low (Out):*					
Description j	Node j	Type	Cond	Temp j	Heat j	Description j	Node j	Type	Cond	Temp j	Heat j
INNER PANEL SIDE	HOKIES.102	Lin	1.4989	78.80	-21.40	SBAND PMOD	HOKIES.703	Lin	20.076	95.49	48.52
INNER PANEL SIDE	HOKIES.103	Lin	1.4989	80.49	-18.87	INNER PANEL SIDE	HOKIES.105	Lin	1.4989	97.79	7.06
INNER PANEL SIDE	HOKIES.107	Lin	1.4989	81.55	-17.27	PPU	HOKIES.701	Lin	29.215	93.29	6.22
INNER PANEL SIDE	HOKIES.104	Lin	1.4989	90.58	-3.73	GPS MOD	HOKIES.704	Lin	97.496	93.13	5.36
INNER PANEL SIDE	HOKIES.106	Lin	1.4989	90.97	-3.16	OUTER PANEL TOP	HOKIES.1	Lin	100	93.07	-0.10
CROSSLINK	HOKIES.702	Lin	29.257	92.98	-2.84	CROSSLINK	HOKIES.702	Lin	29.257	92.98	-2.84
OUTER PANEL TOP	HOKIES.1	Lin	100	93.07	-0.10	INNER PANEL SIDE	HOKIES.106	Lin	1.4989	90.97	-3.16
GPS MOD	HOKIES.704	Lin	97.496	93.13	5.36	INNER PANEL SIDE	HOKIES.104	Lin	1.4989	90.58	-3.73
PPU	HOKIES.701	Lin	29.215	93.29	6.22	INNER PANEL SIDE	HOKIES.107	Lin	1.4989	81.55	-17.27
INNER PANEL SIDE	HOKIES.105	Lin	1.4989	97.79	7.06	INNER PANEL SIDE	HOKIES.103	Lin	1.4989	80.49	-18.87
SBAND PMOD	HOKIES.703	Lin	20.076	95.49	48.52	INNER PANEL SIDE	HOKIES.102	Lin	1.4989	78.80	-21.40
SPACE	HOKIES.99999	Rad	0.00632	-460.00	-1.01	SBAND PMOD	HOKIES.703	Rad	9.73E-06	95.49	0.00
INNER PANEL	HOKIES.109	Rad	0.00162	20.89	-0.11	OUTER PANEL SIDE	HOKIES.5	Rad	3.87E-06	97.28	0.00

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- **The user also has control over the Format (i.e. decimal places) of the output as well as the minimum heat flow to display (Min Heat). Furthermore, the type of heat flow is defined by the *Heat To* field. If this value is *Node*, then heat flow to nodes will be output; if it is *MajorGroup,* then the heat flow will be to major groups. By entering either nodes or groups in the *Node i* field, the user may output heat flow between nodes, between groups, or between nodes and groups.**
- **In the two outputs shown, one is displaying the heat flow between node HOKIES.101 and all Major Groups. The other is showing the heat flow between the Panels Major Group and all other Major Groups.**

	Description	INNER PANEL TOP			
	Node i	HOKIES.101	Temp	93.076	
	Time	(6) SS	Format	0.000	
	Sigma	1.71E-09	Min Heat	0.0	
	Toffset	460	Heat to	MajorGroup	

SUMMARY:	In	Out
Conduction	57.271	57.475
Radiation	0.000	1.123
Source	1.367	-
Sum	58.638	58.598

Low (Out) to High (In):

Node j	Type	Cond	Temp j	Heat j
INNER	Lin	8.993401	0.000	-57.375
PANELS	Lin	100	91.011	-0.100

High (In) to Low (Out):

Node j	Type	Cond	Temp j	Heat j
ELEC	Lin	176.044	83.767	57.271
PANELS	Lin	100	91.011	-0.100
INNER	Lin	8.993401	0.000	-57.375
PANELS	Rad	1.19E-06	91.011	0.000
BATTERY	Rad	3.06E-06	89.297	0.000
OUTER	Rad	1.92E-05	0.000	0.000
ELEC	Rad	7.14E-05	83.767	-0.001
MISC	Rad	0.00162	0.000	-0.111
SPACE	Rad	0.00632	-460.000	-1.011

	Description	#N/A			
	Node i	PANELS	Temp	91.011	
	Time	(6) SS	Format	0.000	
	Sigma	1.71E-09	Min Heat	0.0	
	Toffset	460	Heat to	MajorGroup	

SUMMARY:	In	Out
Conduction	79.546	77.652
Radiation	0.000	3.970
Source	1.980	-
Sum	81.526	81.622

Low (Out) to High (In):

Node j	Type	Cond	Temp j	Heat j
INNER	Lin	17.9868	0.000	-77.652
BATTERY	Lin	151.13	89.297	4.837
ELEC	Lin	544.204	83.767	74.709
SPACE	Rad	0.02373	-460.000	-3.733
MISC	Rad	0.002782	0.000	-0.190
ELEC	Rad	0.003947	83.767	-0.040
OUTER	Rad	0.00147	0.000	-0.006
BATTERY	Rad	0.000285	89.297	-0.001

High (In) to Low (Out):

Node j	Type	Cond	Temp j	Heat j
ELEC	Lin	544.204	83.767	74.709
BATTERY	Lin	151.13	89.297	4.837
INNER	Lin	17.9868	0.000	-77.652
BATTERY	Rad	0.000285	89.297	-0.001
OUTER	Rad	0.00147	0.000	-0.006
ELEC	Rad	0.003947	83.767	-0.040
MISC	Rad	0.002782	0.000	-0.190
SPACE	Rad	0.02373	-460.000	-3.733

THERMAL MODELING SOLUTIONS

- **Lastly, a fourth group option is available for HeatMaps, called Dynamic Groups. This allows a user to expand and collapse groups for determining the heat flow. Double click cell G1 on the *NodeInfo* sheet to bring up the Dynamic Group Selection. Expand groups until it looks like the screen to the right. Close the selection window, select *DynGroup* under the *Heat To* pulldown menu on *Map1,* and hit return.**
- **This allows the user to investigate heat flows at a detailed level for some areas of the model, while preserving the simplified groups at others. In this case, all nodes in the Panels and Battery paths are represented by the Major groups, but the Elec group is broken out into its three Minor Groups.**
- **This is useful to allow investigation of heat flows at a detailed level without the need for detail in all other groups.**

	B	C	D	E	F	H	I	J	K	L
1	Description	#N/A					SUMMARY:		In	Out
2	Node i	MIDELEC		Temp	71.71		Conduction		35.68	0.00
3	Time	(6) SS		Format	0.00		Radiation		2.13	57.78
4	Sigma	1.71E-09		Min Heat	0.0		Source		20.11	-
5	Toffset	460		Heat to	DynGroup		Sum		57.91	57.78
6										
7	*Low (Out) to High (In):*					*High (In) to Low (Out):*				
9	Node j	Type	Cond	Temp j	Heat j	Node j	Type	Cond	Temp j	Heat j
10	INNER	Lin	71.5	87.78	35.68	INNER	Lin	71.5	87.78	35.68
11	SPACE	Rad	0.39274	-460.00	-55.91	OUTER	Rad	0.074767	87.77	0.75
12	MISC	Rad	0.03827	0.00	-1.87	TOPELEC	Rad	0.029221	93.72	0.54
13	INNER	Rad	3.99E-05	87.78	0.00	BOTELEC	Rad	0.033276	86.57	0.45
14	BATTERY	Rad	0.035045	89.30	0.39	BATTERY	Rad	0.035045	89.30	0.39
15	BOTELEC	Rad	0.033276	86.57	0.45	INNER	Rad	3.99E-05	87.78	0.00
16	TOPELEC	Rad	0.029221	93.72	0.54	MISC	Rad	0.03827	0.00	-1.87
17	OUTER	Rad	0.074767	87.77	0.75	SPACE	Rad	0.39274	-460.00	-55.91